DOCUMENT RESUME

ED 402 677 EA 028 142

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TITLE Education's Equivalent of Medicine's Framingham Heart Study.
PUB DATE Mar 96
NOTE 20p.; Paper presented at the Annual National Conference on Creating the Quality School (5th, Oklahoma City, OK, March 27-30, 1996).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; Blacks; *Class Size; *Early Intervention; *High Risk Students; Kindergarten; Longitudinal Studies; Outcomes of Education; Prevention; Primary Education; Program Effectiveness; Scores; *Teacher Student Ratio
IDENTIFIERS *Student Teacher Achievement Ratio Project TN; Tennessee

ABSTRACT

Since 1984, large-scale, longitudinal, and experimental research on class size has been conducted in Tennessee. Project STAR (Student-Teacher Achievement Ratio) changed in 1989 to the Lasting Benefits Study (LBS) and Project Challenge. In 1985 almost 7,000 students in kindergarten were randomly assigned to either small classes, regular-sized classes, or regular-sized classes with a full-time aide. This paper summarizes the project's research findings to date. Findings indicate that small is better, especially in the early years of schooling. The program resulted in improved academic performance, improved cognitive scores on measures, fewer grade retentions, more on-task time for teachers, a higher level of student engagement, and a reduced test-score gap between white and nonwhite students. The paper also compares STAR to the Framingham (Massachusetts) Heart Disease Epidemiology Study. It describes how the program can ameliorate the effects of poverty and other factors that place children at risk. The achievement gap between black and white students does not open at grade 1 if both groups are placed together in small kindergarten classes by random assignment. Small classes beginning in kindergarten or first grade seem to prevent later school problems; however, later application of small-class treatment appears to have limited value. Seven tables are included. (Contains 13 references.) (LMI)

EDUCATION'S EQUIVALENT OF

MEDICINE'S FRAMINGHAM HEART STUDY

Paper Prepared for
Fifth Annual National Conference on
Creating the Quality School
Oklahoma City, OK

March 27-30
1996

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EDUCATION'S EQUIVALENT OF MEDICINE'S FRAMINGHAM HEART STUDY [1]

Introduction

Since 1984, large-scale, longitudinal, and experimental research has been conducted in Tennessee. That such long-term and serious research can be sustained in education is unusual, but what is even more important is the genuine Institution of Higher Education (IHE), State Education Agency (SEA), policy boards, and Local Education Agency (LEA) cooperation that, in many cases, has outlasted the persons who represented these levels of work throughout the years. Governors, legislators, State Board of Education representatives, education commissioners, principal investigators (P.I.s), superintendents, principals and teachers, researchers and SEA staff have changed, but the research continues. The accumulating database that makes this work education's equivalent of Medicine's Framingham Heart Study

What began as Project STAR (Student-Teacher Achievement Ratio) evolved in 1989 to the Lasting Benefits Study (LBS) and Project Challenge. Both the STAR and LBS studies spawned subsidiary and ancillary studies employing the STAR and LBS database or conceptual bases). Both STAR and LBS built upon the foundation "pilot study" called the DuPont study that preceded STAR by two years and helped interest TN policy people in a serious study of class-size and student achievement. The DuPont study was reported mostly in several student dissertations conducted at Tennessee State University (TSU) and directed by Dr. Helen Bain who became a STAR PI in 1984.

Project STAR Synopsis

Project STAR began in fall, 1985 with almost 7,000 pupils in kindergarten (K) who were randomly assigned in 79 schools in 42 of TN's 138 school districts. Pupils were in classes of 13-17 (Small or S), 22-26 (Regular or R) and Regular with a full-time aide (RA). Teachers were assigned to classes at random. In fall, 1986 pupils moved to grade 1 and remained

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Revision of paper at AASA, San Diego, 3/8/96.

basically in the same class-size units, moving as cohorts each year. New teachers and aides [if in the (RA) condition] were randomly assigned. This process repeated each grade K-3. After grade 3 the pupils returned to the regular class-size condition of the district. The sample increased at grade 1 as TN did not have required K at the time that STAR began. New pupils who entered in grade 1 were randomly assigned to (S), (R), (RA). As part of the "in-school design" each school that had (S) also had at least one (R) and one (RA) class. This simplified the study in terms of data collection, etc., but also controlled for district and building-level variables.

Each spring the pupils were tested in controlled conditions on the appropriate form of the Norm-Referenced Test (NRT), the Stanford Achievement Test (SAT) batteries. Students also took TN's objective-driven Criterion Referenced Test (CRT) called Basic Skills First (BSF). Researchers collected demographic data, logs of teacher and aide time, questionnaire data on classroom practices, student self-concept responses on the SCAMIN, and a variety of context and other data.

Although the experiment was self-contained in the participating schools with all three conditions, researchers established an external set of 21 comparison schools. Selected from within STAR districts, the comparison schools were as nearly like the STAR school in each comparison-school district as possible. The only contact with these schools was that researchers obtained the test scores of the age-alike cohorts, K-3.

Two main rules guided STAR: 1) students should not in any way be penalized by being in STAR and 2) researchers touched nothing except class size and, of course, random assignment, but (R) and (RA) were randomized with the (S). All analyses were conservative. Researchers recognized the influence of teachers and classmates on a pupil's scores and used the class average as the unit of analysis because this was a study of class size. There were at least 100 classes of each (S, R, RA) condition each year, K-3.

STAR was conducted by a consortium of four IHEs, directed by staff of the SEA, and advised by a) an advisory board of LEA and other persons and b) a panel of external consultants. To assure objectivity, the primary analysis was contracted to an external statistics and design consultant; secondary and confirmatory analyses were done by the various PIs. Summary results of STAR have been reported elsewhere. (S) classes outperformed (R) and (RA) classes statistically and educationally significant in all locations, for all groups, each year, and cumulatively for all three years. These gains were both on CRT and NRT measures. By the end of grade 3, there were not differences in such things as attendance or discipline, but in (S) there were a) less retention in grade and b) more early identification of youngsters who needed special attention to succeed. Studies of teachers in high and low-performing (S) and (R) classes indicated some of the things that (S) conditions seemed to facilitate.

Other STAR-Related Studies

LBS researchers are still following STAR pupils and are analyzing the test and other results. There have been two studies of student engagement and participation of STAR pupils (grades 4 and 8). Students are in grade 10 in 1996. In grade 8, the last year for which we have analyzed data, the (S) pupils were still outperforming (R) and (RA) pupils in a statistically significant manner, but differences among the groups were fading some after 5 years of no "treatment."

In Project Challenge state policy persons provided funding so that 16 of the state's poorest systems could apply STAR finding and reduce class sizes K-3 to about 1:15. On average, the Challenge systems that started the 1:15 treatment in 1989 ranked well below the state average performance [2] are now (1995) near or above the state average. This was a move from about an average of 99 in 1989 to 78 in reading in 1995 and from 85 to 56 in math on state tests at grades 2, 3, and 4. Challenge is not an experiment; it is a policy application of experimental results. The way Challenge was phased in provided some important information for future considerations. Most important is the conclusion that the (S) treatment seems most useful if it is applied as early as possible in a pupil's school experience. Small classes beginning in K or grade 1 seem to prevent later school problems, but later application of (S) apparently has limited remedial value.

Throughout STAR, LBS and Challenge the research team has kept the positive cooperation of all "actors" in this study. The state has put modest funding into the continuation. Local personnel have continued to assist in data collection. They have also helped researchers with some "ancillary" studies including dissertation research to answer new questions as they arise and by assisting in the two participation studies by having teachers do special data collections. The STAR-related database is "on-line." The database includes over 11,000 students, with key demographics, test scores, and records of schools attended, special services, etc.

Added Elements of Cooperation

Although we have not yet begun to "milk" the database, we do have tentative answers to key questions. Our analyses continue to raise other questions. STAR's findings have also excited some continuing cooperation outside of STAR's immediate legacy.

Two STAR-incited studied have added to the knowledge base and have confirmed STAR's results by achieving very similar effect sizes (ES) for small-

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[2] With 138 districts in the state, the average rank would be 69. A district ranked 70-138 would be below average. For summary reporting purposes, we discuss the average rank of the 16 Challenge districts and the improvement of that rank over time.

class gains. Success Starts Small (SSS) was a year-long observational study in two schools matched except for K and grades 1 and 2 class sizes. One school averaged 1:24; the SSS school averaged 1:14.

In Burke County, NC there was a "natural experiment" of youngsters in grades 1-3 in classes of 1:17 and of 1:25 or so. Researchers from TN and NC worked with staff from a Regional Laboratory (SERVE) to analyze student gains and teacher behaviors in 1:17 and 1:25 classes.

Results from these and the STAR studies are slowly getting into the research literature and generating interest in some states. At last count, leaders in about 15 states have, or are seriously considering, class-size ideas as part of state-wide education planning and legislation. This list may be incomplete: AZ, CA, FL, IL, IN, KY, NC, NE, NH, OK, TN, TX, UT, VA, WV.

Researchers from TSU are cooperating with researchers at the University of London and with other groups to share and re-analyze the database. The cooperation will expand the reanalyses using different procedures will provide added important findings.

Summary of Findings

What are we learning? Of greatest importance, we are able to show definitively what many parents and teachers have long known. Small is better, especially in the early years of schooling. Better seems to be much more than simply better test score results (Hey, home-school supporters, private school people and even some education-for-pay people not only know this , they do small classes). Here are a few not-surprising findings, or tentative findings awaiting more detailed analyses:

- Pupils in (S) outperform pupils in (R) and (RA) on all cognitive measures and the early treatment lasts at least into grade 8 after the K-3 start.
- Pupils in (S) have relatively fewer examples of poor discipline.
- The (S) classes seem to overcome the known deleterious effects of big schools.
- Random assignment pupils [STAR (R) pupils] outperform non-random assigned pupils K-3 [STAR Comparison (R) pupils).
- Teachers have more on-task time in (S) than in (R) and this stays constant all year. In (R) the on-task behaviors decline over the year (tired teachers and kids. Burnout?).
- There are relatively fewer retentions in grade in (S). This is not only better education practice, but it could save money, and grade retention is closely associated with dropouts. If so, reducing retention in grade could be very

efficient and help pay for smaller classes.

- Students in (S) are more engaged and participative in school more than are students in (R) and (RA). This may influence their staying in school to graduation.

- The traditional test-score gap between white and non-white pupils does not open as much in (S) as in (R) and (RA). The merits of this will require serious analysis, especially in the total structure of U.S. education.

- Early identification of special needs in (S) seems to reduce later special education placements. This may save much money for use in other ways.

- Student scores in (S) are up in all tested areas, not just in targeted areas characteristic of special projects (reading and math, usually). Thus (S) is a broad-scale change, not a bandaid (project), approach to improving achievement.

- It appears that "instructional" aides do not contribute much to pupil gains. Recall, however, that in STAR there was no special training of teachers or aides. Training may help, but without such training, students in K-3 perform better in (S) than in (R) and better in (R) than in (RA) generally. Consider the implications of this, especially since the group that gets least benefit seems to be Black males, and teacher aides are commonly used as a remedial intervention in education.

- The (S) treatment is more preventative than remedial. If a student does not experience 1:15 when first entering the "system," there is little gain unless educators use tutorials or expensive other "treatments."

Now What?

Table 1 is a summary of some of the sources and authors that make up the expanding STAR-related database. The few results identified here for the benefits of (S) over the "regular" way are enough to point to an entirely different plan for American education. STAR researchers do not advocate just reducing class sizes , K-3, and continuing with education as usual. The K-3 start opens up new vistas for education restructuring. A resturcturing , if you will, built on data and driven by cooperation to see what progress is being made, and why. Wouldn't it be professional, for once, to point to a substantive research base to support what we do or propose to do in education? Where, for example, are data to support many of the "fads" that

are "buzzwords" such as "TQM", or "technology"? [3] The research base is there for class-size changes. Let's use it until substantive research provides equal or better results to guide change. Let's build change upon it. Now.

STAR's Comparison to Major Research in Another Field

Beginning in 1948 the federal government began supporting a longitudinal study of heart disease. The study involved no specific "treatment," but did build upon a carefully developed database that allowed generalizations to be made over time. The Framingham Heart Disease Epidemiology Study had, among other things, the following characteristics. (Table 2)

Table 2. Summary Description of the Framingham Heart Study*

Since 1948 he federal government's Framingham heart study has followed a representative sample of 5,209 adult residents in Framingham, Massachusetts. These people have been tracked using:

- standardized biennial cardiovascular examination,
- daily surveillance of hospital admissions,
- death information, and
- information from physicians and other sources outside the clinic.

* Information from varied computer-based sources.

[3] Data do support some projects such as Success for All or Reading Recovery, but in many settings, more than half of the pupils need special projects. The "bandaid" mentality of adding projects will not provide the base for substantial education reform. A problem exists here because the researchers who developed the projects have a "product" to sell, and products are visible and glitzy.

The objective has been to study the epidemiology of cardiovascular diseases -- to learn the circumstances under which they arise, evolve and terminate fatally in the general population.

The Framingham study is designed to find out how those who develop cardiovascular diseases differ from those who remain free of the diseases over a longer period of time.

To provide some idea of the size of the Framingham study and one division by demographics (male-female), consider Table 3 which shows information on the study population and sample. The study was set up between 1948 and 1950. The persons enrolled for the study ranged in age from 30 to 59 designated as a stratified random sample of residents of Framingham, MA.

The following are excerpts from the six-year follow-up study of the original Framingham Heart Study. (Kannel, Dawber, Kagan, Revotski, & Stokes, 1961). When reading these items, think of terms used in education, such as dropout, early intervention, poverty, etc.

> Because coronary heart disease (CHD) is often manifested as sudden unexpected death or "silent" infarction and since the immediate mortality in those surviving to enter a hospital is still distressingly high in spite of the best therapeutic efforts, it appears that a preventive program is clearly necessary. (p. 30. Emphasis added.)
>
> ... it seems evident that efforts at prevention must begin many years before the appearance of clinical CHD. (p. 30)
>
> This allows the identification of the coronary prone individual many years before the occurrence of clinically recognizable disease. (p. 30)

Multiple interrelated factors have been demonstrated to be associated with increased risk development of CHD. (p. 30. Emphasis added.) [Consider multiple risk factors for at-risk children, such as poverty + race + one parent + ... ?]

Table 3. Composition of Framingham Heart Study Group[1]

	Total	Men	Women
Random Sample	6507	3074	3433
Respondents	4469	2024	2445
Volunteers	740	312	428
(TOTAL)	(5209)	(2336)	(2873)
Respondents Free of CHD*	4393	1976	2417
Volunteers free of CHD	734		
Total Free of CHD Framingham Study Group	5127	2283	2844

*Coronary Heart Disease. ( ) added to original table.

[1] Kannel, W. B., Dawber, T. R., Kagan, A., Revotskie, N., & Stokes, J., III. (1961, July-December). Factors of risk in the development of coronary heart disease--six-year follow-up experience: The Framingham Study. Annals of Internal Medicine, 55 (old series, vol. LIX). 33-50. (p. 35). Table shown as Table 1 in original source.

Table 4. Summary of STAR Database with select variables by Class Type (Small or S at 13-17, Regular or R at 22-26, and Regular with Aide or RA).

Class Type	Sex			Race				Poverty		
	M	F	Total	B	W	O	Total	FL	NFL	Total
S	1674	1488	3162	1040	2058	28	3126	1672	1491	3163
R	2283	2062	4345	1682	2593	31	4306	2486	1870	4356
RA	2167	1907	4074	1451	2545	28	4024	2355	1727	4082
Total	6124	5457	11581	4173	7196	87	11456	6516	5088	11601
%	52.9	47.1	(20)*	36.1	62.8	.8	(145)*	56.1	43.9	(0)*

* Missing Data

For the idea emphasized in the first quotation, consider the efforts of the best teachers working hard and trying to overcome the barriers preventing a successful "treatment" for youngsters who have "survived" such things as poverty or poor early childhood experiences only to enter school for this "treatment." Think about the considerable available evidence to show the dramatic chance of improvement if early intervention projects are used appropriately (e.g., Reading Recovery, Success for All, Early Prevention of School Failure, etc.). STAR results also show how some problems of later schooling can be ameliorated.

Table 4 includes data from Project STAR showing pupils (K-3) who had at least one year of involvement in one of three class-type conditions: Small class or (S) of 13-17 pupils, Regular class or (R) of 22-26 pupils, or Regular with Aide class or (RA). The STAR population was 11,601, or more than twice the Framingham study. Table 4 shows distribution into race (B, W, O), Sex (M, F) and Free Lunch (FL) or Not Free Lunch (NFL). Note that on the poverty index, more than half of the pupils are "at risk." Since this is the case, should we expect that a program for at-risk students should be designed to replace the present project mentality?

Noted demographer Harold Hodgkinson has identified poverty as the major variable that impedes a pupil's school success. He also noted the high percentages of minority pupils who are in poverty. Hodgkinson (1992) said:

> Given that minorities are more likely to be in poverty than whites (most poor kids are white, although black and Hispanic kids have a much higher percentage of their total number poor) and given our look at the future, we might ask how schools are likely to fare with the clientele we have isolated. The best guess would be -- *reasonably well*. . . . America's lowest 35 percent (in terms of school attainment) is truly awful, due to factors that were present when they first knocked on the kindergarten door. (Factors such as: poverty, out of wedlock birth, teen births, cocaine-addicted at birth, short of food and housing, born premature, are only a few.) (p. 8. Emphasis added.)

Yet, educators must work with all youngsters who arrive at the schoolhouse door, regardless of their entering condition. (This in spite of TQM's ideal of zero defect!) If pupils are "at risk" when they arrive at school, then educators must seek to remedy those problems as well as seeking to advance the academic achievement agenda. Hodgkinson (1995) says that the best predictor for school failure is poverty, a point echoed by others.

Cooley (1993) notes that in Pennsylvania just three variables (poverty, single-parent home, and parent not a high school graduate) account for over "60 percent of the variation in the average student performance" in the school districts studied (p. 5). These districts also generally have fewer resources for education, making them acutely feel "the difficulty of the educational task." In other words, it is not that these pupils cannot learn, it is a question of added time and financial resources to address "the difficulty of the educational task."

Although small classes may seem like they will cost more than larger classes, first impressions may be deceiving. Data from Project STAR, however, suggest that both retention in grade and the pesky test-score achievement gap between White and non-White students are ameliorated by starting the students in their schooling experiences in small classes of

approximately 1:15 (e.g., Finn and Achilles, 1990; Robinson, 1990). This small-class condition also improves the probability that students will participate more actively in positive aspects of schooling, and that such participation improves the student's chances of obtaining positive test results and of not withdrawing from school (Finn, 1989). Finn (1993) also addresses the role of multiple risk factors and the potential of the small-class condition to help reduce the impact of these. The conditions mentioned here all pose avenues to reducing education costs and achieving added gains.

Table 5 shows the average score for student promotion from kindergarten to grade 1 in Project STAR, using the appropriate level of the Stanford Achievement Test (SAT) test battery, the SESAT. Notice that a child with a score of 423, 424, 425, and 426 would, on average, be promoted in a small class (S) but the same child would be retained in a regular class (R).

Tables 6 and 7 are based on results obtained on Tennessee's criterion-referenced test (CRT) built on the curriculum objectives. The Basic Skills First (BSF) test had several items relating to each curriculum objective. To pass an objective, a student had to get correct responses on 3 of 4 (or 4 of 4) questions relating to the objective. Besides computing the percent passing, it was also possible to tabulate the absolute number and percent of all BSF questions that a student answered correctly.

Table 6 presents data on the percent of White and Black students passing the BSF. Notice the large difference (17.4) between Black student performance in (S) and in (R) and the relatively low absolute difference (4.1) in the performance when the Black and White students are compared in (S). Black students show a test-score deficit between (S) and (R) that is 2.4 times that of White students in the equivalent class-size condition.

Table 7 reports the percent of grade-one reading BSF items correct by class type (S or R) by race at grade 1 both for Project STAR students who had kindergarten (K) and those with no K. Besides demonstrating the test-score value of K, the results clearly show the differential and positive benefits to Black students of starting school in a (S) kindergarten. Black students in (S) in (K) correctly answered 87% of the items for grade 1 correctly, and Black students in (R) answered only 77% of the items correctly, a benefit of 10% favoring the (S) condition. White students in the (R) condition in (K) answered 86% of the grade-1 items correctly, and those in the (S) condition only were 2% better, at 88%. It is clear that by placing Black and White students in (R) classes (the usual practice in schools), an achievement gap opens and that gap does not open at grade 1 if both groups are put into the (S) condition by random assignment.

In Letters to a SERIOUS Education President, Sarason (1993) states that education can have one of two purposes, to repair and to prevent (p. 3). Until now educators have seemed to emphasize repair, using a hodge-podge of bandaid-like projects geared to remediation, rather than emphasizing the potential of education to prevent through an improved program base. The sort of information presented here from Project STAR would clearly trigger changes in medicine. Based on results emphasizing prevention of CHD, doctors have been urging better lifestyles, improved diets, and increased exercise (among other things). There have been marked improvements in preventing and in treating CHD. And, in education, what action have educators taken on at least equivalent data?

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References, etc. are available.

Numerous articles, papers, and reports of class-size research are available through ERIC (using as authors Achilles, Bain, Boyd-Zaharias, Finn, Nye, or some of the other authors shown in Table 1 for material that is STAR related). The RPC/TSU also has available a bibliography of STAR, other class size and related articles and research report. For a small fee, materials are available directly from RPC/TSU, as noted on the cover of this summary.

Table 1. Samples of Studies Derived from and Building upon the STAR Initiative Classed as "Subsidiary" (directly from STAR), "Ancillary" (building on and using STAR database) and "Related" (triggered by STAR results and usually involving STAR researchers).

CATEGORY, TITLE & PURPOSE *	DATE(S)	AUTHOR(S) OR PUBLICATION
Subsidiary Studies		
• Lasting Benefits Study to follow STAR pupils	1989-Present	Nye et al., 1994
• Project Challenge (TN)	1989-Present	Nye et al., 1994, Voelkl, 1995
• Participation on Grades 4, 8	1990, 1994	Finn, 1989
		Finn and Cox, 1992
Ancillary Studies (Use or extend STAR data. Some of these are dissertations.)		
• Retention in Grade	1994	Harvey, 1994
• Achievement Gap	1994	Bingham, 1993
• Value of K in Classes of Varying Sizes (tests scores)	1985-1989	Nye et al., 1994-1995
• School-Size and Class Size Issues	1985-1989	Nye, K., 1995
• Random v. Non-Random Pupil Assignment and Achievement	1985-1989	Zaharias, 1995
• Class Size and Discipline in Grades 3,5,7	1989,1991,1993	In Process, Hibbs.
• Outstanding Teacher Analysis (top 10% of STAR teachers)	1985-1989	Bain et al., 1992
Related Studies		
• Success Starts Small: Grade 1 in Chapter 1 (1:14, 1:23) Schools, Burke Co., NC	1993-1995	Achilles et al., 1994

* This list is not complete. It provides samples of the types of studies done. Not all authors appear in the references in the exact way listed here. This table appears in several STAR reports in substantially this same form.

Table 5. Average scores for promotion/retention by class type for STAR, Kindergarten to Grade 1. (Scores on SESAT.)

	S	R	Difference Favoring (S)
Promote	441	435	6
Retain	422	427	5 *
Range*	19	8	

* A pupil with a score of 423, 424, 425, 426 will be retained in Regular class but the same pupil will be passed to the next grade in a Small class, on average.

Table 6. Average Percent of Pupils Passing BSF Reading: Grade 1, STAR.

		Class Type		
Status	Grade	Small	Reg.	Difference (S-R) or (S) Average
Minority	1	65.4%	48.0%	17.4
Non-Minority	1	69.5%	62.3%	7.2
Difference *		4.1%	14.3%	

* Results suggest that the usual practice of "Regular" classes opens the achievement gap between Black and White pupils early in schooling. In STAR the "Regular" classes may have been smaller than the U.S. average; they were about 23 pupils.

Table 7. Percent by class type, Race (BL/WH), of BSF items correct, grade 1 with K and without K (rounded).

		BSF Grade 1 Reading (% Correct)		
		With K	No K	DIFF
White	S	88	85	3
	R	86	80	6
	Diff	2	5	--
	RA	86	82	4
Black	S	87	79	8
	R	77	74	3
	Diff	10	5	--
	RA	79	77	2
Difference by Race by Class Type				
W-B	S *	1	6	
	R	9	6	
	RA	7	5	

* Note that (K) is a benefit to pupil scores by grade 1, and that if both Black and White pupils are randomly placed in Small classes (1:15) the achievement gap is very small when compared to the difference in Regular classes of about 1:23.

AUTHOR NOTES

The National Education Longitudinal Study (NELS) database may be a more true comparison with the Framingham Heart Study than STAR since NELS is not involved in "treatment," but only in collecting data and in studying status vis-a-vis post hoc issues.

The forthcoming national Early Head Start (EHS) study will have large amounts of data from both experimental (various EHS treatments) and control youth and families. This has the potential to extend NELS downward to ages 1-4 (the Control group) and also to extend the Perry Preschool, Head Start, STAR, etc. results of early treatment (the various EHS treatments involved will be the experimental base).

The author, however, contends that STAR and similar databases should not only provide outstanding education research opportunities, but that the STAR data should be used as a base for program (vs project) restructuring of education.

The author appreciates the library research assistance of Billie Rohl, the typing of Marcie Kennedy, and the suggestions of Susan Hoover, Ed.D. Any glitches, however, are the author's.

EA028142

U.S. Department of Education
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Publication Date: 3/28/96

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